Materials Science

AN MFM STUDY OF MAGNETIC DOMAINS IN MAGNETOELASTIC TORQUE SENSORS

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We have recently determined (last year) in our laboratory that a ferromagnetic high-speed maraging steel alloy of 18% nickel in iron (known as C250) is one of the best materials for use in the construction of a "ring type" torque sensor on a non-ferromagnetic shaft used for power transmission in either industrial or transport applications. Following appropriate heat treatment of the C250 ring, we were able to create two distinct portions of the ring in which a high degree of circumferential magnetization was maintained with a saturated alignment of the magnetic domains, but with opposing directions of polarization. This is due to both the high circumferential coercive force within the material following the heat treatment, as well as the "hoop stress" induced within the ring by its shrink-fit onto the torqued shaft. The same type of magnetic arrangement in a hollow ferromagnetic shaft can be used to produce a "shaft type" torque sensor. In our case, the material used for the shaft was a steel alloy of 0.5% chromium and 0.3% nickel (known as 0-1). Previously unknown, however, has been the exact nature of the interface between these two regions of opposing circumferential magnetization. In this study, we have used the magnetic force probe of our recently acquired atomic force microscope (AFM), in an imaging technique known as magnetic force microscopy (MFM), to determine the width and sharpness of the domain wall and of the transition region between the two oppositely polarized regions of both the "ring type" and "shaft type" sensors. This study has also allowed us to determine the relative extent of the circumferential magnetization in the neighboring regions on either side of the domain wall. A comparison is also made between the domain wall widths and relative depths of magnetic alignment in the two sensor types.